


Nutraceutical Crop Production in High Tunnels



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Today's Outline



1. Some Definitions
2. What Nutraceuticals Do
3. Pure Compounds vs. Whole Foods for Disease Prevention
4. Production Approaches including High Tunnels to Enhance Nutraceutical Concentrations
5. Future Direction Needed to Develop this Kind of Production into a Sustainable System

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The Definitions

Functional Food
A food that provides the body with the required amount of vitamins, fats, proteins, carbohydrates, etc. needed for its healthy survival.

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The Definitions

Nutraceutical
A functional food that aids in the prevention and or treatment of disease(s) and/or disorders.

Since the term was coined, its meaning has been modified. Health Canada defines nutraceutical as:
'a product isolated or purified from foods, and generally sold in medicinal forms not usually associated with food and demonstrated to have a physiological benefit or provide protection against chronic disease.'

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The Definitions

Phytonutrient
A substance derived from plants, such as a pigment, that is beneficial to health, especially one that is neither a vitamin nor a mineral.

A nonnutritive bioactive plant substance, such as a flavonoid or carotenoid, considered to have a beneficial effect on human health.

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Some Examples of Phytonutrients...


Carrots (β-carotene)
Reduces cancer and enhances the immune system

Blueberries (anthocyanins)
Neutralizes the potential for damage to our DNA which leads to the development of cancer

Tomatoes (lycopene)
Reduces the risk of prostate and digestive tract cancers

Soybeans (isoflavones)
Reduces the risk of heart disease and several cancers (breast, lung, and prostate)

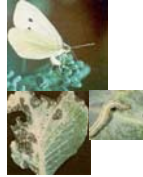
Cabbage (glucosinolates)
Reduces risk of cancer, particularly lung and colon cancer



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Glucosinolates and Their Function?

- Sulphur - containing compounds
- Distinctive flavor and aroma
- Natural defense against insects and diseases
- Correlated with reduced incidence of various forms of cancer



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Lung Tumor Induction in Rats

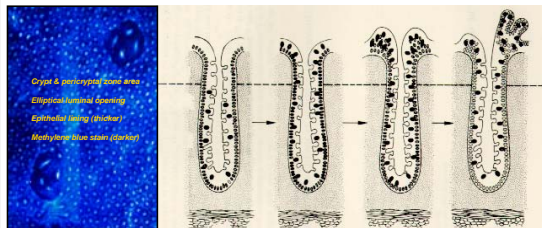
Treatment	Number of Rats	Number of Rats with Lung Tumors (%)
NNK	56	39 (70)
NNK + PEITC	59	3 (5)*
PEITC	19	2 (11)
None	18	1 (6)

* P < 0.00001 compared to NNK alone.
S.S. Hecht et al., Cancer Epidemiol., Biomarkers & Prev. 5:645-652 (1996).

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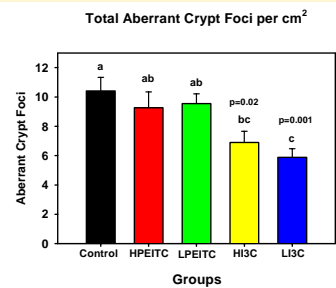
Aberrant Crypts of the Colon

- Precancerous lesions
- Correlates with tumor formation



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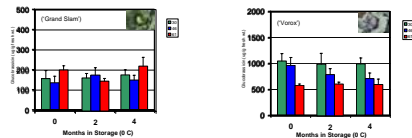
Aberrant Crypt Occurrence Influenced by I3C?



Andreas Platte and Dan Gallaher, UMN
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Glucosinolates (as whole food) Working in the Diet?

- Determine the Effects of Feeding Cruciferous Vegetables on Colon Cancer Risk in Rats
- Compare Different Cabbage Cultivars that are High or Low in Glucobrassicin Concentration



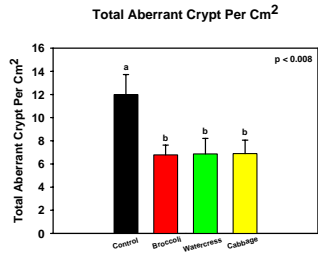
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Glucosinolates (as whole food) Working in the Diet?

- Male Rats in 4 Diet Groups (15) for 16 Weeks:
 - Control diet (AIN-93G)
 - Broccoli diet (14.36% fresh broccoli by weight)
 - Watercress diet (10% fresh watercress by weight)
 - Cabbage diet (22.61% fresh cabbage by weight)
- All vegetable diets were calculated to contain 95 mg of glucosinolates / kg of diet.

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Andreas Platte and Dan Gallaher, UMN

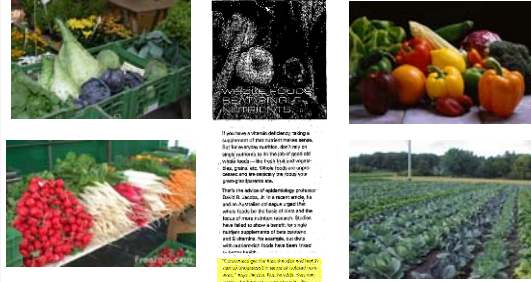
Glucosinolates (as whole food) Working in the Diet?



Andrea Plato and Dan Gallaher, UMN

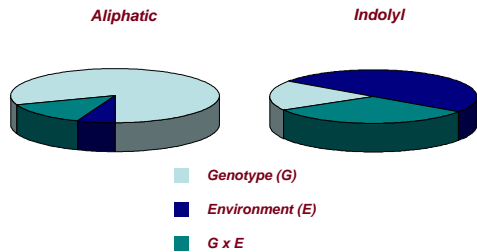
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Nutraceuticals Consumed as Whole Foods is Gaining Support



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Glucosinolate Variation Attributed to Genotype, Environment, and G x E



(Kishad, M.M. et al., J. Agr. Food Chem. 47:1541-1548, 1999)

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Glucosinolate Variation Attributed to Genotype, Environment, and G x E

POTENTIAL STRATEGIES

- Genotypic Variability
- Population Density
- Nitrogen x Sulfur Fertility
- Light Manipulation
- Biotic Stress Inducers
- Seasonal Variation
- Seasonal Extension
- Temperature
- Maturity Indexing
- Postharvest Storage

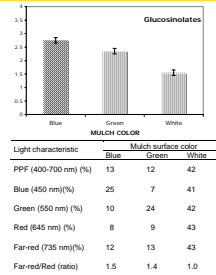


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Colored Mulches Can Enhance Glucosinolate Concentration

Amount of Blue light and ratio of Far-red to Red light reflected onto turnip leaves alters total glucosinolates in the roots of 'Purple Top' turnip.

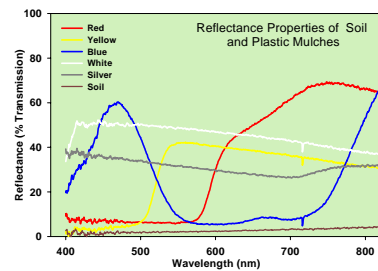
Blue and green mulch enhanced glucosinolates the most and resulted in a higher shoot to root ratio.



(Antonious et al., Photochem. Photobiol. 64:605-610, 1996)

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Light Manipulation



(Justen, Fritz, Wang, Cohen, and Gardner, University of Minnesota)

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High Tunnels from Growers Supply (FarmTek)



2008 Costs

2 tunnels
 - double layer roof
 - air inflation system
 - heavy duty sidewalls
 - 2 - 30 x 48 = \$12,000

electronic curtains
 4 @ \$600 = \$ 2,400

hardware/lumber \$ 500

Total \$14,900

\$7,450 / high tunnel

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High Tunnels from Growers Supply (FarmTek)



Inflator motor

Double layer roof provides for a 4" air layer for greater heat retention and improved snow shed.

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High Tunnels from Growers Supply (FarmTek)



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High Tunnels from Growers Supply (FarmTek)

Electronically Controlled Curtains



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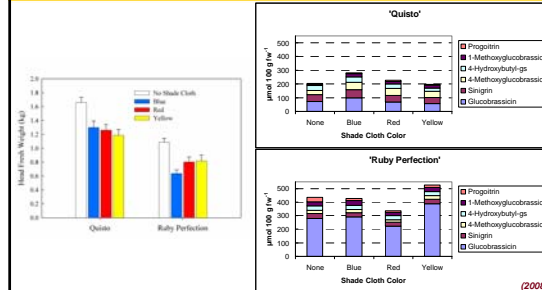
Light Manipulation



Cabbage in High Tunnels – 2007/2008

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Colored Shade Cloth Effect on Glucosinolate Concentration



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Ginger Production in Minnesota?!



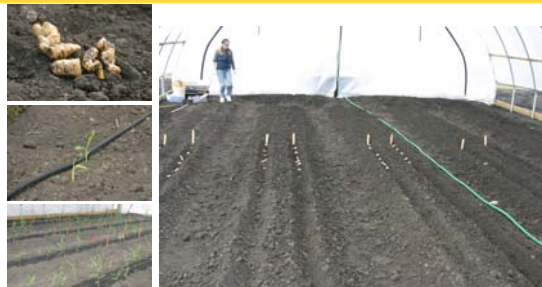
Zingiber: A, entire plant (1 inch size); B, flower; C, habitus; D, transverse section of rhizome.

Characteristics of Ginger

- Tropical / Subtropical Plant requiring 9-11 months to mature
- Asexually propagated
- High temperature, high humidity, and shade requirements
- Naturally produces 6-gingerol, a bioactive compound that has been associated with reducing the risk of cancer

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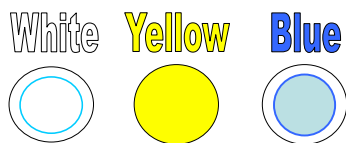
Ginger Production in Minnesota?!



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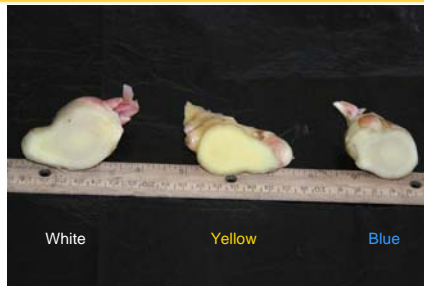
Visual Differences in Varieties

**Ginger Identification
Internal Core Color**



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Visual Differences in Varieties



White Yellow Blue

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Ginger Production



2007

Planted Late March
Raised Beds
12" spacing
Blue, White, Yellow

2008

Planted Early April
Raised Beds
6 and 12" spacing
Etheption Soak
Blue, Yellow

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Ginger Production



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Ginger Production



90 DAP

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Ginger Production



Approaching harvest

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Ginger Production



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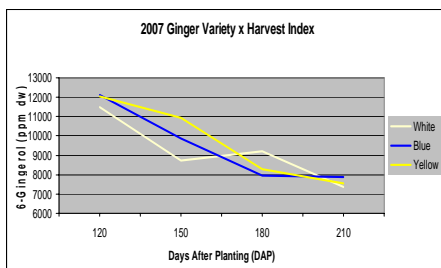
Ginger Production



Harvested 11/11/2008

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Harvest Index Effect on 6-Gingerol Concentration

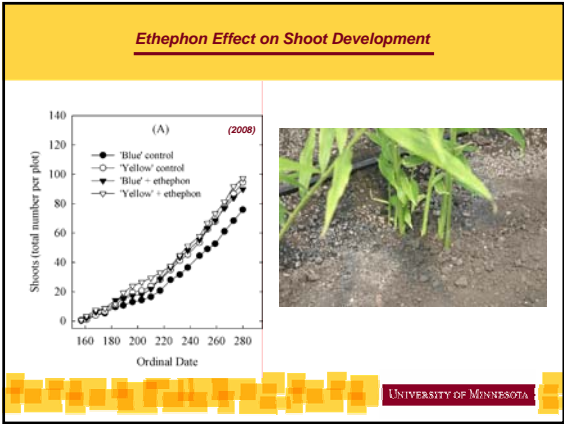


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Variety Biomass Yield Differences and 6-Gingerol Yield (2007)

Variety	DAP	6-Gingerol Concentration			Rhizome Dry Wt.		6-Gingerol Yield	
		µg/ml	µg/g dw	ppm x 10 ³	g	g/600 ft ²	mg/ft ²	
White	120	229.88	11493	11.5	1.48	3.1	5.1	
White	150	174.49	8725	8.7	9.07	14.2	23.7	
White	180	164.45	9223	9.2	12.13	20.1	33.6	
White	210	147.38	7369	7.4	63.16	83.8	139.6	
Blue	120	242.66	12133	12.1	1.28	2.8	4.7	
Blue	150	197.58	9879	9.9	6.70	11.9	19.9	
Blue	180	158.79	7940	7.1	30.63	43.8	73.0	
Blue	210	157.87	7894	7.9	43.23	61.4	102.4	
Yellow	120	241.03	12052	12.1	0.92	2.0	3.3	
Yellow	150	219.00	10950	11	7.17	14.1	23.6	
Yellow	180	165.32	8266	8.3	26.17	38.9	64.9	
Yellow	210	151.14	7557	7.6	76.67	104.3	173.8	

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Future Needs in the Development of Nutraceutical Crops

- Production Consistency
- Sensory Acceptance
- Quantification /Certification
- Real /Perceived Value

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